

Comparing Mortgage Credit Risk Policies

An Options-Based Approach

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Abstract

Buckley, Karaguishiyeva, Van Order, and Vecvagare analyze the structure of approaches to mortgage credit risk that are now being used in a number of OECD and transition economies. The authors' basic approach is to show how option pricing models can help measure and evaluate the risks of various schemes. They find that:

- Mortgage default insurance can be a cost-effective tool for both improving housing affordability and efficiently addressing some of the rationing that characterizes this market. When correctly structured, as

it is in a number of transition and market countries, this kind of program can be expected to reduce nonprice rationing at an actuarially fair price. At the same time, considerable care must be exercised in the development of such instruments.

" Geographical risk diversification, particularly across borders, can play a major role in the success of these programs. Such diversification could be important not only in smaller transition economies but in EU countries as well.

This paper—a product of the Urban Unit, Transport and Urban Development Department—is part of a larger effort in the department to study low-income housing. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Oumi Himid, room F4K-300, telephone 202-458-0225, fax 202-522-3232, email address uhimid@worldbank.org. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. Robert Buckley may be contacted at rbuckley@worldbank.org. May 2003. (23 pages)

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Comparing Mortgage Credit Risk Policies: An Options Based Approach

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This work was initiated for a conference on mortgage credit risk that was held in Vilnius Lithuania in Oct. 2001. The conference was co-hosted by the World Bank, the Government of Lithuania, and the Canadian Government. Preliminary simulations were reported to the conference and the results reported here reflect discussions and other presentations at the conference. Van Order and Vecvagare were supported by a Dutch Trust Fund at the World Bank for low-income housing. We thank Mirja Adler, Hans-Åke Palmgren, Andrea Cirman, Achim Duebel, Britt Gwinner, Olivier Hassler, Austin Jaffee, Larry Jones, Eric Klopfer, Alenka Krassing, Kare Lilleholdt, Hans Mersmann, Bertrand Renaud, Bengt Turner, Andreas Trofimovas, Gediminas Tuarjonas, Aivis Reinholds, Judy Sanders and Gerhard Wieringa for comments on earlier drafts and assistance in interpreting the data and behavior of a number of different companies.

I. Introduction

Because of concern with credit risk and information problems, lenders ration mortgage credit. They do this mainly in two ways: first, they limit access to credit only to those able to afford to make significant down payments; and second, they limit eligibility for loans to those able to pay less than a specific share of their income for repayments.¹ This rationing may make mortgage lending more prudent, but at the same time it also reduces the welfare of those who are rationed out of the market by non-price means. For instance, Schmidt-Mohr (1997) argue that lenders' reliance on high down payment lending can be a very costly as well as regressive way to solve the informational problems associated with such loans.

Reliance on rationing to determine loan eligibility arises because of lenders' reluctance to lend against borrowers' future income, or, alternatively, borrowers' inability to pledge their human capital. It also arises because mortgage credit risk is largely driven by the behavior of house prices so that the risk is geographically concentrated. As a result, lenders, and particularly those lenders with geographically concentrated mortgage portfolios, in effect, purchase prudence by allowing only those with accumulated savings access to credit.²

Such rationing characterizes mortgage lending in most countries. Indeed, outside of the five transition countries that we examine down payments of 40 percent or more of initial house value is the situation in most transition economies. A similar if not as extreme situation also characterizes lending in many OECD countries, and it has generated a variety of subsidy and insurance schemes to help address the costs posed by this rationing, particularly for first-time homebuyers.³

In general two types of public policy solutions that have been developed. One is to provide subsidies for households so that they are able to save enough in a second mortgage to "top up" the low loan-to-value ratio loan they can get from banks. The other is the provision of default insurance whereby borrowers pay an insurance fee to be able to borrow loans with larger loan to value ratios.⁴ One of the questions we address is: how do these approaches compare as

¹ The first type of constraint rations those households without savings from homeownership. The second rations out those households who have enough savings for the down payment but cannot satisfy the payment-to-income constraints lenders use to qualify borrowers. An extensive literature indicates that in the U.S. and U.K. the first constraint is more binding. It is also the case that lenders ration based on borrower credit history, which in the U.S. is increasingly important.

² The potential macroeconomic consequences of such rationing have also long been a subject of discussion. For instance, in his Nobel Lecture Akerlof (2002) discusses credit rationing as one of the information problems that can have significant macroeconomic consequences.

³ Hendershott and White (2000) discuss various tax subsidy schemes used in Australia, Canada, Germany, Sweden, Ireland and the U.S. Other public programs are operative in the UK, France, Norway, Finland and Denmark. These latter programs are discussed in Turner, Whitehead and Jakobsson (2000).

⁴ The most frequently used homeownership subsidy scheme to subsidize second mortgages is the Bausparkassen savings scheme used in Germany, Austria, and France. This scheme takes a number of forms but generally first provides subsidies to young families to save for a number of years, and then provides them with a subsidized loan to top up their mortgage loan. This subsidized loan is for a multiple of the amount saved. The objective is to use subsidies to encourage savings for larger down payments so there is less need for a second loan, and then to subsidize the higher costs of the second loans. Besides default insurance and subsidies as ways to address rationing another approach to address the rationing problem has been proposed by Case, Shiller, and Weiss (1993). It

ways to address the non-price rationing that characterizes mortgage lending? For transition countries this question has some currency because six of them have recently adopted the subsidy approach while five have opted for public provision of default insurance.⁵ In addition, both approaches are now under consideration in other countries, such as Russia, Mexico, and India.

In the five transition economies we review —Estonia, Kazakhstan, Latvia, Lithuania, and Slovenia—the public sector plays a major role in insuring mortgage default, as it does in almost all the OECD countries where it operates.⁶ Hence, direct public sector bearing of mortgage credit risk is a wide-spread phenomenon in both market and newly-emerging transition countries.⁷ Accordingly, a second topic addressed here is how to measure and monitor the public role in the provision of this service.

We address this latter topic at some length because while public provision of insurance can help complete markets and lower credit costs, it can also entail major risks or implicit transfers if the institutions do not manage and price risk properly. The factors that determine which result is obtained are: the reserves held and mortgage insurance fees charged, and the riskiness of the environment. That is, does the company have sufficient capital and charge prices for the guarantee such that the government risk-bearing is fully compensated?⁸ Moreover, if the government risk-bearing is not fully compensated how does the government account for the guarantee in its budget so that public risks are controlled, and any service provided at a price less than cost is treated as a subsidy?

In addition to its fiscal effects, insurance program structures can also be important because of the indirect effects they can have on a country's financial sector development.⁹ For

involves establishing an index-based futures market and options for house prices. This approach has recently been developed in London, see Iacoviello and Ortalo-Mague (2002).

⁵ Bausparkassen subsidy schemes have been introduced in Croatia, the Czech and Slovak Republics, Hungary, Poland, and Slovenia. Public default insurance operates in Estonia, Latvia, Lithuania, and Slovenia. In Kazakhstan the public sector has capitalized a company that will begin operating soon, see Merrill and Whitely (2002).

⁶ OECD countries with publicly-sponsored default insurance include Belgium, Canada, Sweden, the Netherlands, Finland, France, the U.S. and the U.K. The U.S., U.K., Israel, and Canada also have private insurers. In addition, as of September 2002, Spain, like Australia, has only a private default insurer. There are also often public limitations on the provision of private default insurance. In the U.S., for instance, private insurers were prohibited until 1956 following the bankruptcy of the industry during the Great Depression. The strong performance of the public insurer, FHA, led to their re-establishment. See Blood (2002) for a fuller discussion of the terms under which default insurance is provided in OECD countries, and the European Mortgage Federation (1989) for a somewhat dated discussion of many of the details of mortgage-related insurance in a number of European countries.

⁷ Even where there is no direct public role in bearing credit risks, as in Germany, there is often a significant indirect public role. For example, where large loan-to-value mortgage loans are made without a direct guarantee, as is often the case in Germany, there is still frequently a significant public role in mortgage credit risk bearing due either to the public ownership of the banks providing the loans, the regulations on higher risk-weighting for high loan-to-value mortgages, or the guarantees provided to banks by the German Development Bank, KfW. See Schuder (2002) for a discussion of the last approach.

⁸ This is the approach to regulation of Fannie Mae and Freddie Mac, the two large U.S. secondary market institutions, by their regulator, the Office of Federal Housing Enterprise Oversight, OFHEO. See the *OFHEO Report to Congress* (2001).

⁹ Government involvement in mortgage markets can be an important impediment to financial sector development because of the scale of public support and the fact that this support is often provided in non-transparent ways, see MacLennan, Muelbauer, and Stephens (1998) for a discussion of mortgage credit policies in market economies, and Struyk (2000) for a discussion of transition countries.

example, is it the case that an ongoing public role in the industry is warranted—as some have argued based on the failure of private insurers in the U.S. and Canada during the Great Depression—because the risk is uninsurable?¹⁰

Similarly, in the case of the EU countries, how do national mortgage policies affect lenders' ability to exploit the geographic diversification possibilities that can arise now that there is one large single currency market? For instance, do various individual country guarantees create competitive distortions in the broader EU market as has been suggested by the European Banking Federation?¹¹

Finally, due to the smaller geographical size of the transition countries that have adopted the insurance approach, there may be gains that can be obtained from shedding some portion of this risk across larger geographical areas.¹² How can these smaller markets create a regulatory environment that is both prudent and welcoming of more risk-bearing by more geographically diversified institutions? More generally, given the very recent and often piecemeal emergence of de novo financial sectors in all of the transition countries it is important to achieve a better understanding of how small economies' macroeconomic risks can be most effectively allocated, monitored, and controlled.

In sum, a better understanding of the scale of public sector involvement and government regulation of mortgage credit risk allocation should be of immediate interest to policy-makers in both the transition economies as well as those of the European Union. In both cases a better understanding of the public role in mortgage credit risk allocation would help establish a level playing field across institutions, as well as a regulatory environment which would allow lenders to allocate risks to those with a comparative advantage in such risk-bearing.

¹⁰ Among others, see Foster and Herzog (1981), Pennington-Cross and Yezer (2000), and, according to the European Mortgage Federation (1988), it is the view of German credit institutions.

¹¹ In 1999 the Federation lodged a formal complaint with the European Commission against the system of public guarantees for Landesbanken and savings banks in Germany.

¹² Macro shocks can have significant effects on financial sector stability and public contingent liabilities. For example, as shown by Caprio and Klingebiel (1996), in the past fifteen years the banking sectors of more than 58 countries became technically insolvent often with large public costs. Mortgage credit risk is a particularly important aspect of risk distribution in geographically small countries because in such countries there are not as many distinct housing markets so that these risks cannot as easily be hedged across markets. For example, as discussed further in the text, Quigley and Van Order (1991), show that variations in regional mortgage default rates in the U.S. are both considerable—they vary by a factor of five across regions—and are negatively correlated, indicating strong geographical diversification possibilities

The plan of the paper is as follows. In the next section we discuss how a version of Merton's (1973) options model pricing of deposit insurance guarantees can be applied to mortgage credit insurance and mortgage credit risk regulations. Then, in section III we apply the model to the terms and conditions of 12 forms of insurance now in use in 9 countries and discuss the relative risks of the various programs. Section IV considers some of the complications that arise in exercising the underlying options that affect the pricing of these institutional guarantees. It presents empirical results from the U.S. to demonstrate how these complications can affect both the default behavior of individuals and the estimates of the guarantee fees needed for financial soundness. Based on these results, in section V, we review a number of policy questions. A final section provides a summary and conclusions

II. Guarantees of Financial Institutions as Options.

Based on Merton's application of the Black-Scholes option pricing model, a financial institution with asset value V uses debt financing in the form of a zero-coupon bond issue. At the maturity date of the bond, T , the firm owes B dollars to the bondholders, and in the event of default the firm must forfeit its assets. We recognize the implicit option with the following observation: at maturity T , if the value of the firm's assets, V , is greater than the value of the bond, the firm will pay the bondholders B and net $V-B$; alternatively, if the value of the firm's assets is less than the value of the bond, the firm will default. In this case, the bondholders will claim V , and the firm's equity will have zero value.

If the firm purchases a third-party guarantee, directly analogous to the deposit insurance modeled by Merton, ensuring that the value of the debt remains constant at B , we can use option-pricing theory to value the guarantee. If the value of the firm is less than the face value of the bond, the firm will act as before, paying bondholders B and netting $V-B$. In this case the guarantee has value zero. However, in the event of default, the guarantor will pay the difference between the value of the debt and firm equity ($B-V$) to the bondholder. Thus, the guarantee has value $\min(0, B-V)$, a non-negative value. This valuation of a bond guarantee is identical to that of a put option with stock price " V " and exercise price " B " and absent the guarantee it can be thought of as the discount on the firm's zero-coupon bonds due to credit risk.

From the firm's perspective the debt guarantee is a put option that gives it the right to sell its assets " V " at price " B " at an exercise date identical to the maturity date of the bond. The value of the option is governed by the volatility of the value of the firm's assets. Thus, the traditional Black-Scholes pricing equation can be used to evaluate the implied assumptions about how risky the environment is seen by the firm or the firm's regulators, i.e. what is implied volatility of the firm's asset value. This is given by

$$G(T) = Be^{-rT} \Phi(x_2) - V\Phi(x_1)$$

where :

$$\begin{aligned} x_1 &\equiv \left\{ \log(B/V) - \left(r + \frac{\sigma^2}{2}\right)T \right\} / \sigma\sqrt{T} \\ x_2 &\equiv x_1 + \sigma\sqrt{T} \end{aligned} \tag{1}$$

where V is the current value of the assets of the firm, T the maturity date, σ^2 the variance rate per unit of time for logarithmic changes in the value of assets and $\Phi(x)$ the cumulative normal distribution.¹³

The same concept can approximately be applied to mortgage guarantees both on an institutional and individual basis. First consider the institutional guarantee.

In the case of a publicly-owned or sponsored mortgage insurance company, the government guarantees availability of additional resources to cover any shortage in the insurance company's capital. In the case of a mortgage insurance company it has liabilities ("B") to mortgage lenders in the event of a borrowers' default and it has assets ("V") in the form of capital. Because the capital is more or less fixed as a set ratio to the insurance in force, the government, as a guarantor of the insurance company, is concerned with the volatility of claims from the mortgage lenders to the insurance company.

Lenders' claims, on the other hand, are determined by the default of the insured borrowers. The risk of this default, however is determined largely by the households exercise of their individual default option. Hence, in effect, the government guarantee is an option (the insurance company's put) on a borrower's option (the homeowner's put) and rigorous evaluation of the risks would require the pricing of an option on an option, a quite complicated mathematical model.

But, the complications are not only computational. For example, non-quantifiable differences in legal recourse also matter in determining how ruthlessly or even whether the household exercises its default option.¹⁴ In addition, borrowers are also affected by the constraints on their ability to exercise another option embedded in the mortgage—the prepayment option, and these constraints on the prepayment option are quite different. In some countries, such as Germany, prepayment is effectively not an option, in most other countries is in an option that can in some cases be explicitly purchased while in others various forms of this option are embedded in the loan terms. Finally, as we discuss further in section IV, the borrowers' default option is also characterized by asymmetric information in which individuals know how much value they place on the indirect costs of exercising the option and the insurer does not.¹⁵ In a word, then, it is not at all clear that such modeling is worth the candle. Nevertheless, with a number of simplifying assumptions we can make direct and conservative estimates of the value of the government's guarantee for specific economic environments, or alternatively, for given guarantee terms, we can infer just how volatile an environment is assumed by regulators.

¹³ This methodology can be extended to more complicated options, for instance options that extend over several periods. However, for the purposes of this paper use of only one period was found to be sufficient. It is well known that the solution to models, such as equation (1) have the intuitively pleasing property that the value of the option is the risk-adjusted expected present value of the costs of the option. This result allows for practical solutions to complicated options via simulation techniques, such as "Monte Carlo" models.

¹⁴ See Jones (1993) for analysis of the significant effects that legal differences with regard to recourse in two Canadian provinces have on default behavior.

¹⁵ See Jaffee and Stiglitz (1990) for a review of this literature.

Our first simplifying assumption is to ignore the cohort effects that can arise over time. In other words, for simplicity, and following the approach taken in Case and Shiller (1996), we assume that the insurer's portfolio is represented by an average loan-to-value ratio for loans which all have the same down payment, were originated at one point in time, have the same amortization schedules, and whose prices move together. This approach prohibits the higher than average earnings (as well as losses) from past cohorts to fund new insurance, see Capone (2000) for a discussion of these effects. It could also affect the relative rankings in the table depending upon both the volatility of a country's growth trend and the degree of international diversification of its financial system. We nevertheless made it because of the computational difficulties in inferring how much inter-temporal and international diversification a country might have. We note, however, that this assumption will tend to make our estimates more conservative.

We also assume that the amount of negative equity realized by firms when a default occurs differs for firms providing insurance for 100 percent of loan balance and those providing first coverage insurance for less than the full loan amount. For insurers providing less than 100 percent insurance, i.e., those co-insuring risks, we assume that the losses realized will be equal to the full amount of the insurance in force, that is 20 to 30 percent of the insured amount. For firms providing 100 percent coverage we assume that the loss will be about 50 percent of the insurance in force. This assumption is made to take into account lenders being more likely to select against an insurer, and particularly a public one, which provides 100 percent coverage, as has been observed in the U.S. by Pennington-Cross and Yinger (2000).

Finally, we assume that there are no legal differences with respect to loan recourse in the event of default and the ability to prepaid loans are identical across countries. With these assumptions, we can formalize how the price charged can affect government transfers. In terms of the Black-Scholes formula, public transfers arise when the value of the mortgaged housing and the insurance company's capital is less than the value of outstanding loans. The probability of exercising this option by the insurance company would be almost non-existent if it had sufficient equity, i.e. if capital and insurance fees were such that the *ex ante* price of the institutional guarantee is approximately zero.¹⁶ In this case there is no subsidy since the expected losses are close or equal to the insurance company's capital. In contrast, a positive option price indicates the premium that the government should charge the mortgage insurance company for its backing.

The above also implies that the present value of insurance fee and capital ("G") for the insurance company should equal the expected present value of losses. More generally, because of the expected present value interpretation of the option pricing model G must be such that:

$$\sum_{t=1}^N \frac{G}{(1+r)^t} UPB_t = \sum_{t=1}^N \frac{E(L_t)}{(1+r)^t} UPB_t \quad (2)$$

where UPB_t is the unpaid balance on the pool, r is the appropriate risk-adjusted discount rate, N is the term of the mortgages in the pool and $E(L_t)$ is the expected loss per dollar of UPB at time t .

¹⁶ It is straightforward to show that, given V , the value of G in equation (1) goes to zero as B goes to zero.

Under these circumstances, the government backing of the mortgage insurance program would involve no direct costs to the government because fees and capital would be sufficient to cover the expected losses.

III. The Implied Risks of the Mortgage Insurance.

Using the methodology described above, we use the specific terms of 12 mortgage insurance programs in 9 countries to estimate the assumed volatility or riskiness of each program. The results are presented in Table 1. Under this approach the government—either as a guarantor or a cost-minimizing regulator—sets the regulations so that the costs of risks are covered by the fees generated.

In our calculations we use an American put option with a term of one year, although changing the term to 5 or 10 years does not affect the relative rankings. We also aggregated the up-front fee and the annual fee into an annual income measure, and assume that these “dividends,” in their entirety, along with reserves, would be used to pay off loan losses. Finally, because we are focusing on one specific instrument in each country rather than a range of, for example, different down payment requirements, the likelihood of the insurer realizing losses is most fundamentally affected by the maximum insurance-in-force to capital ratio that is allowed.

The Table 1 presents the results and basic characteristics of the different programs. In the market economies, the loans discussed are 30 year, 5 percent down-payment fully amortizing mortgage loans and in the Baltic countries and Kazakhstan the loans are 15 year serial loans with 10 percent down payments.¹⁷

Columns 2 through 6 describe the programs’ basic terms. The penultimate column of the table shows the results of solving equation (1) for the implied volatility. The last column presents a relative ranking of the perceived riskiness of the policies with (1) being the safest, and (12) being the riskiest. As can be seen from the table both capital requirements and premiums differ considerably across the countries, and correspondingly, so do the implied volatilities.

Before reviewing our results, it is perhaps useful to once again clarify some of the caveats that limit the inferences that can be drawn. It is, for example, not possible to control for all the differences in the terms of insured loans, legal and judicial infrastructure. In addition, the estimates of volatility are for a portfolio of loans rather than an individual loan. The point of the exercise is to give a relative ranking. Therefore, rather than trying to determine whether the riskiness of the program is under- or over-estimated, we use the results to pose questions: For example, given some perspective on how risky is a country’s economic environment, how safe does a program appear to be?

¹⁷ While it is possible to borrow for maturities of up to 30 years in all of the transition countries in practice most loans are of much shorter term. See the annex for a fuller discussion of the sources of information and details on the program structures. We did not evaluate a Slovenian program that insures loans provided by a publicly-owned insurer for indexed loans. There is some question whether these loans are legally mortgages, reducing the underlying collateral strength for the insurance. See Buckley and Gilbertson (1999). However, when these features are combined with the loans very slow amortization, due to the indexed repayments, it is likely that this is among the riskiest of the programs. Nor did we evaluate a Finnish program operating since 1996 for reasons described in footnote 18.